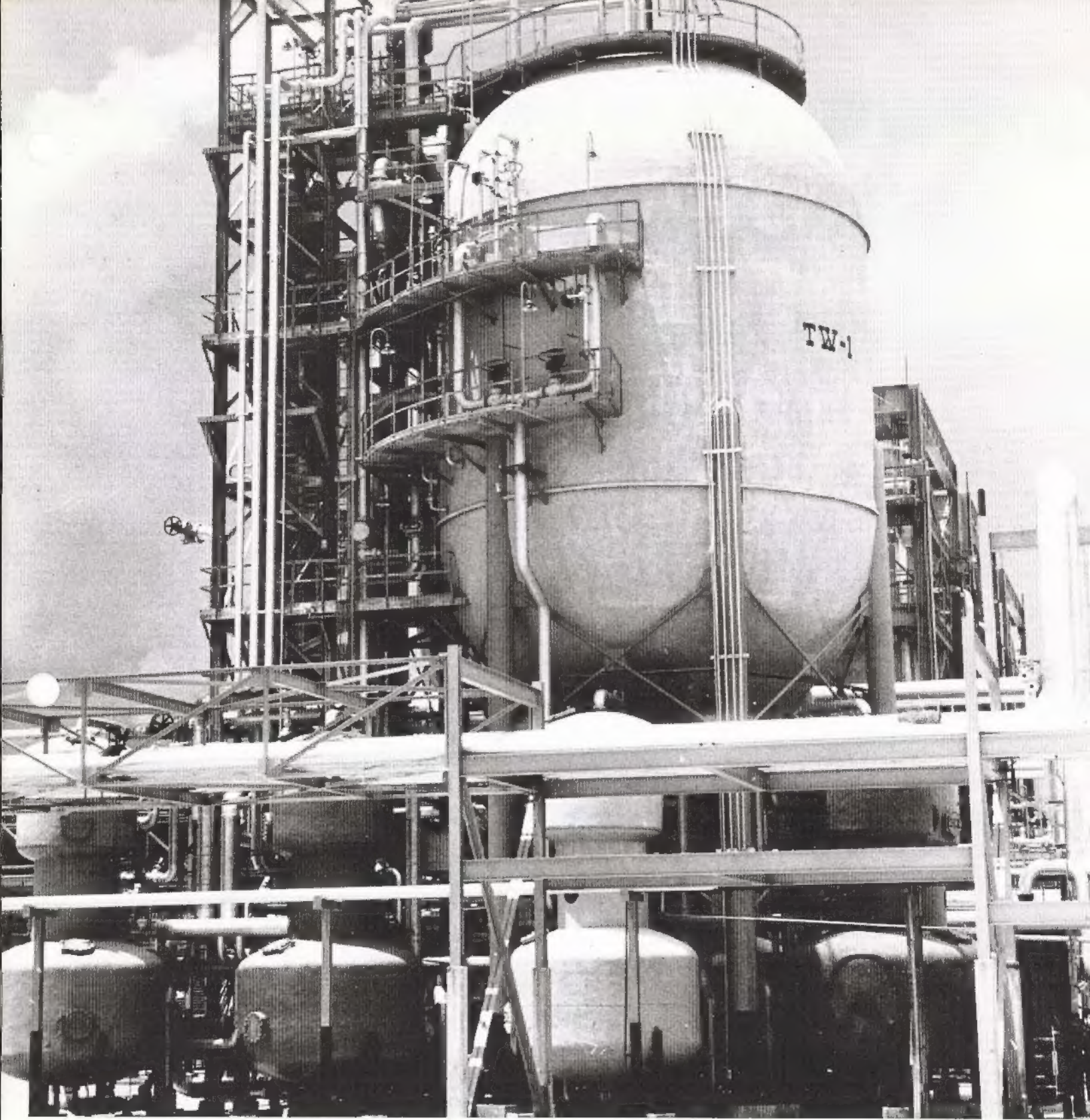
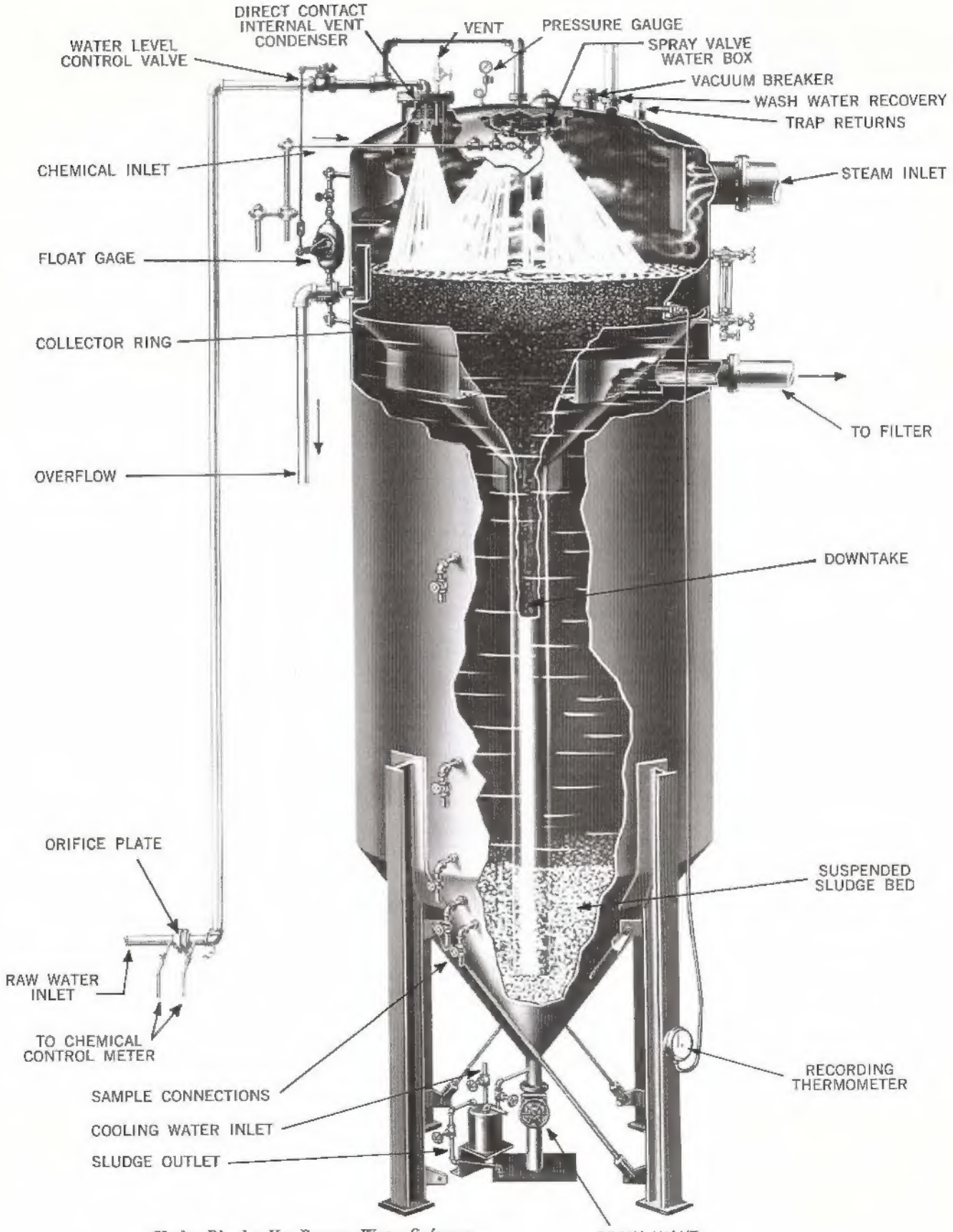


PERMUTIT® HOT PROCESS WATER SOFTENERS

PERMUTIT®

SLUDGE BLANKET HOT PROCESS SOFTENER



Sludge Blanket Hot Process Water Softener

HOT PROCESS SOFTENING

Effective boiler feed water treatment is recognized as an essential requirement for the efficient operation of steam generation equipment. However, the most efficient type of feed water treatment depends upon the type of steam generator, size, operating temperatures and pressures, etc., as well as the raw water conditions.

Hot Process Softening offers outstanding efficiencies when the water requires treatment for alkalinity and silica reduction as well as softening. Boilers may be of the type that operate generally from 600 to 1200 psi pressure and sizes range from 3500 to well above a million pounds per hour steam evaporation.

Operation

The chemical softening reaction takes place more rapidly and effectively in boiling water. Therefore, Permutit Hot Process Softeners heat the raw water to near boiling temperature before the softening chemicals are introduced. Precipitation of the hardness elements, calcium, and magnesium, then takes place most efficiently with a resulting effluent water that is low in hardness.

The precipitated solids settle toward the conical bottom of the tank forming a sludge blanket which is maintained in suspension by the upward flow of treated water. As the treated water flows through this sludge blanket most of its turbidity is entrapped and removed. The effluent from the Permutit Hot Process Softener is then passed through filters where the last trace of suspended matter is removed.

Softening Chemicals

The usual softening chemicals are automatically fed to the settling tank in proportion to the rate of flow of raw water. They are:

a) Hydrated Lime, $Ca(OH)_2$, for precipitating (1) the calcium bicarbonate hardness as calcium carbonate and (2) the magnesium bicarbonate and non-carbonate hardness as magnesium hydroxide. Dolomitic Lime, $Ca(OH)_2MgO$, is sometimes used instead of hydrated lime if the raw water has insufficient magnesium for the required silica removal.

b) Soda Ash, Na_2CO_3, for precipitating the calcium non-carbonate hardness as calcium carbonate.

c) If a Permutit "Q" hot zeolite softener follows the hot process for second stage treatment, it is customary to feed only lime or dolomitic lime.

The precipitated magnesium hydroxide absorbs silica from the raw water. If the raw water does not contain enough magnesium for reducing the silica to a satisfactorily low level, additional magnesium oxide is fed. The sludge blanket is especially efficient in removing the silica.

Condensate and Deaeration

Provision may be made for heating available condensate within the upper portion of the settling tank. If it is necessary to remove all the oxygen from make-up and condensate, a Permutit Deaerator may also be built into the upper portion of the settling tank.

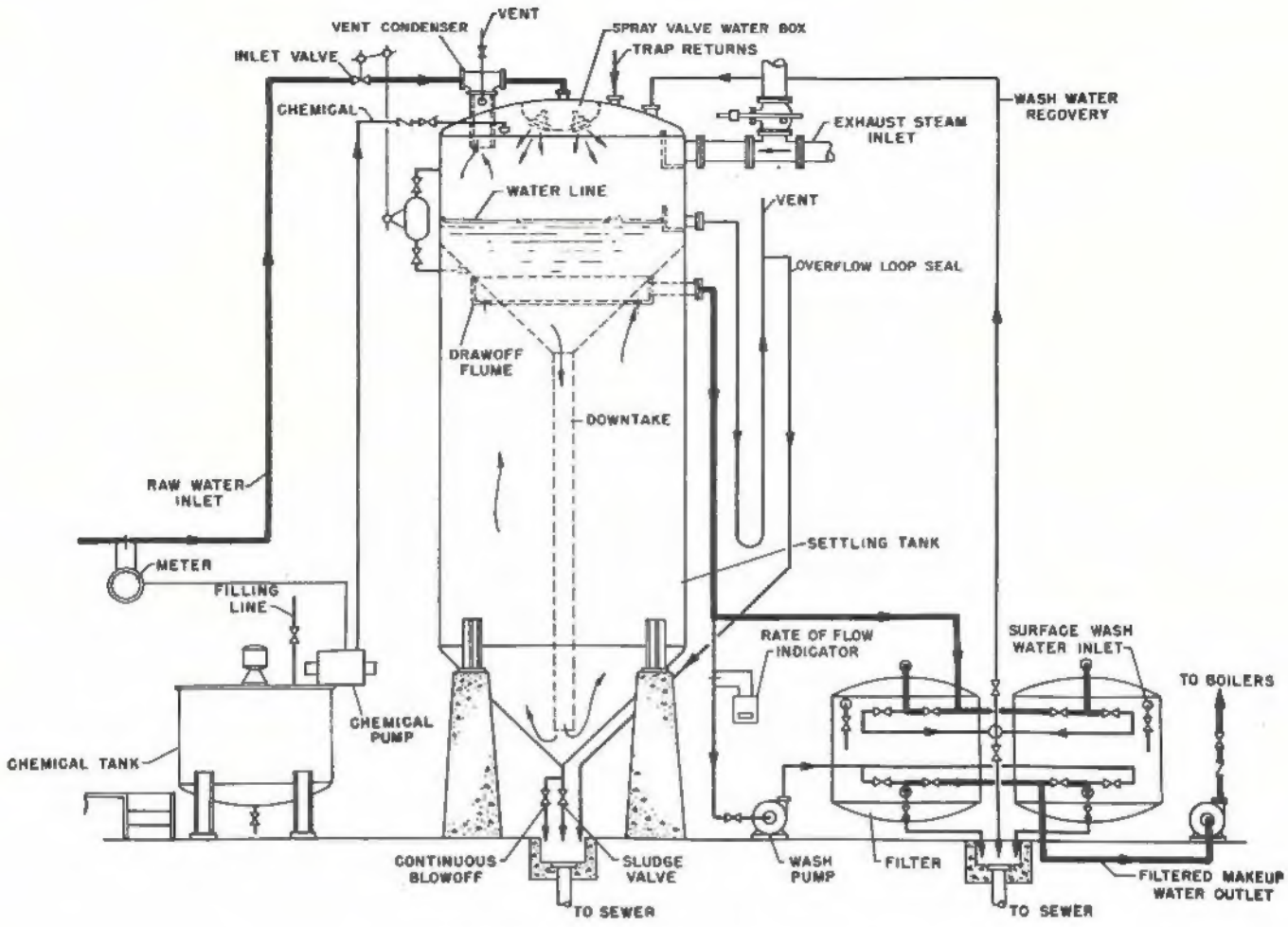


Fig. 2 Type B Permutit Hot Lime Soda Water Softener

TYPE B HOT PROCESS SOFTENER FOR 100% MAKE-UP

The Type B Hot Process Softener is suitable for plants requiring 100% softened make-up water for boiler feed. Raw water is sprayed into the steam space in the upper compartment of the settling tank. Softening chemicals are fed below the sprays and are mixed with the water at the surface by agitation of the falling water. The reaction compartment is funnel-shaped. The stem of this funnel extends downward into a conical bottom and ends at a point sufficiently above the apex to provide proper flow rates for the formation of an efficient sludge blanket. The softened water rises through the sludge blanket and is removed from the top of the settling compartment through a collector ring.

A substantial depth of soft, clarified water is stored between the top of the sludge blanket and the collector ring. This insures that the sludge will not reach the top and enter the collector ring, even if a sudden increase in the rate of flow expands the sludge blanket. This storage also provides wash water for backwashing the filters. Wash water is returned to the top of the settling tank without loss of heat.

A float-controlled valve regulates the flow of water and maintains the desired water level. The entering water passes through a direct contact internal vent condenser which condenses the vented steam and permits the non-condensable gases, released from the water, to escape to atmosphere.

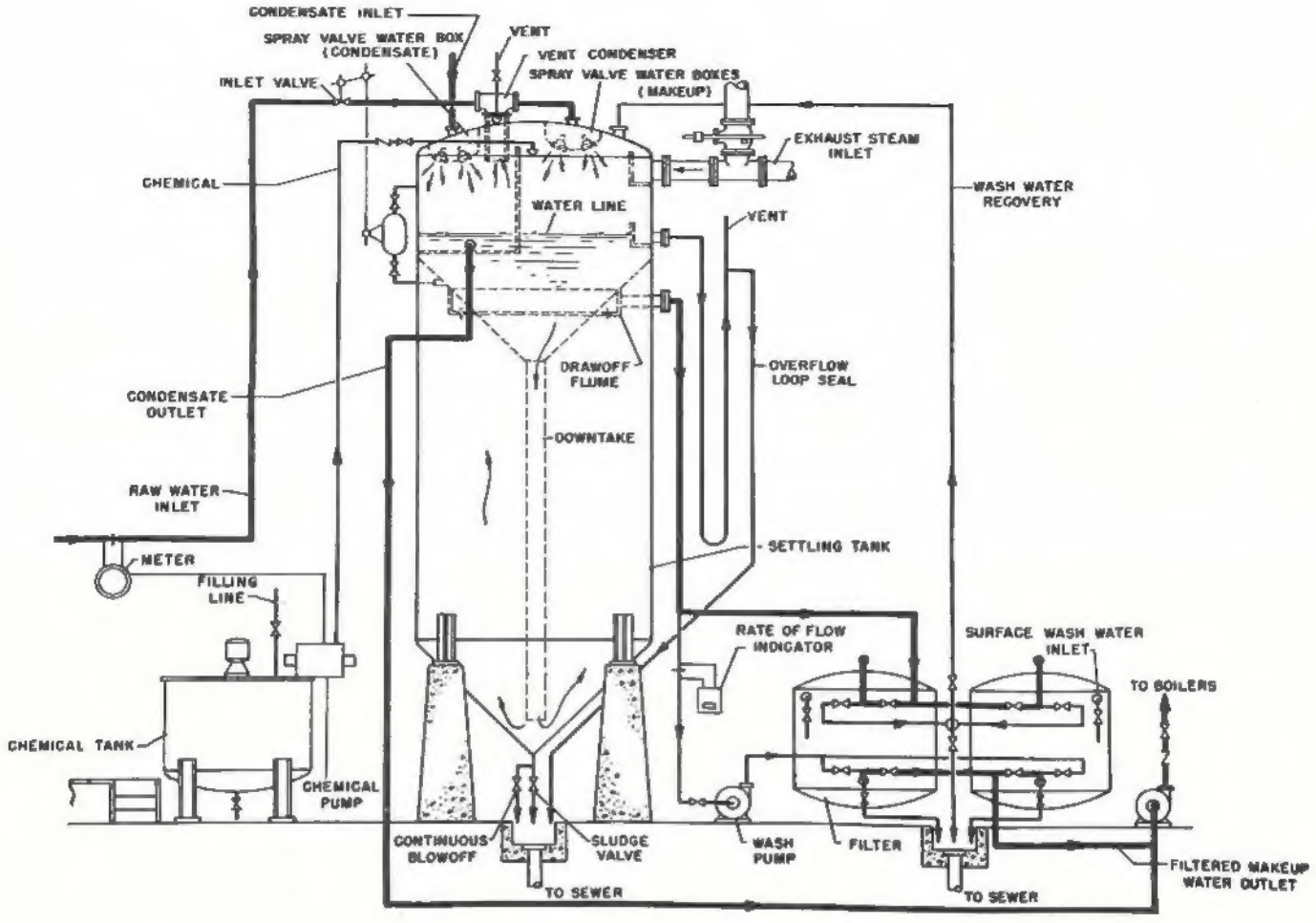


Fig. 3 Type BC Permutit Hot Lime Soda Water Softener

TYPE BC HOT PROCESS SOFTENER

A Combination That Provides for Heating Condensate in Addition to Softening Make-Up

The Type BC Softener provides a separate compartment for condensate heating and storage. The condensate passes directly from the storage section of this compartment to the boiler feed pump suction, thus by-passing the settling tank reaction zone and the filters. It is therefore essential that this condensate should be free from oil and scale-forming solids. The condensate is used for boiler feed in preference to softened make-up. Approximately 10 minute storage. based on the rated capacity of the condensate compartment, is provided thus preventing condensate waste. The float-controlled regulating valve admits make-up water to the softener only if the returned condensate is not sufficient to supply the feed pump. The rest of the tank internals are the same as the Type B design.

Hot Process Softener With Independent Deaerator

When deaeration is required, an independent deaerator may be used with a hot process softener. In this event the deaerator may be of the "thoroughfare" type where the internal vent condenser is omitted and all of the steam for the hot process unit passes first thru the deaerator and then to the settling tank. This design insures sufficient steam volume to properly scrub and deaerate the water at all times.

If a lower temperature condensate is also introduced into the deaerator, the thoroughfare arrangement may not be necessary. In this case the deaerator would be supplied with a vent condenser.

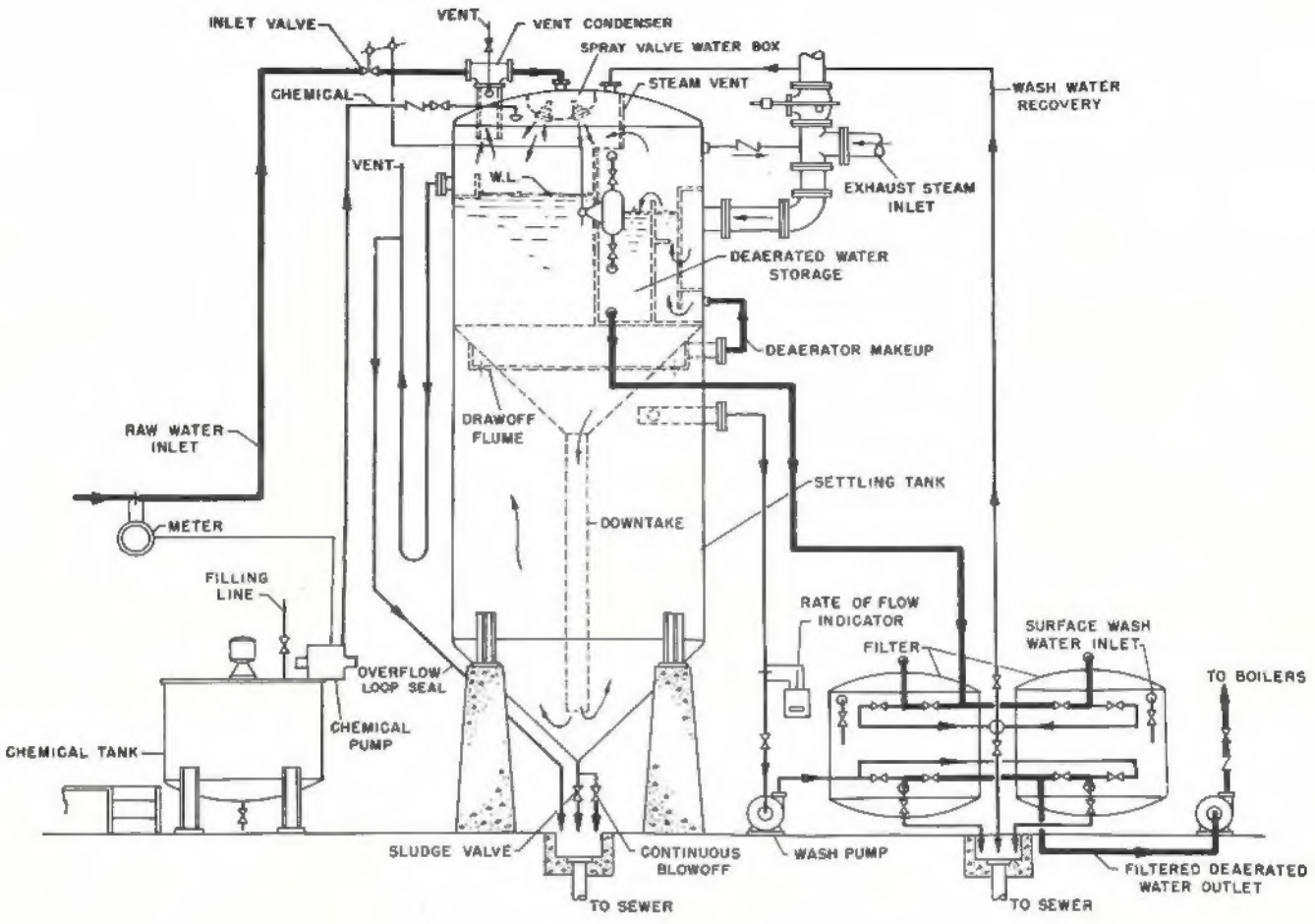


Fig. 4 Type BD Permutit Hot Lime Soda Water Softener

TYPE BD HOT PROCESS SOFTENER

Deaerates As Well As Softens 100% Make-Up For Boiler Feed

The Type BD Softener has an internal deaerator which is built into the upper portion of the settling tank. This deaerator is of the steam scrubbing type. Hot process softening takes place in the identical fashion as in the Type B Softener.

The softened water flows from the collector ring to the deaerator section. All of the inlet steam first passes through the deaerator steam scrubber where the water is vigorously boiled and all oxygen is removed. Since the water entering the scrubber has been previously heated to near boiling temperature, very little steam is condensed, thus eliminating any chance of steam hammering. From the scrubber the water flows to a deaerated water storage compartment. The steam from the scrubber passes to the spray compartment and heats the incoming raw water.

The deaerator removes all non-condensable gases and is guaranteed to reduce the oxygen to zero or not to exceed 0.005 cc per liter.

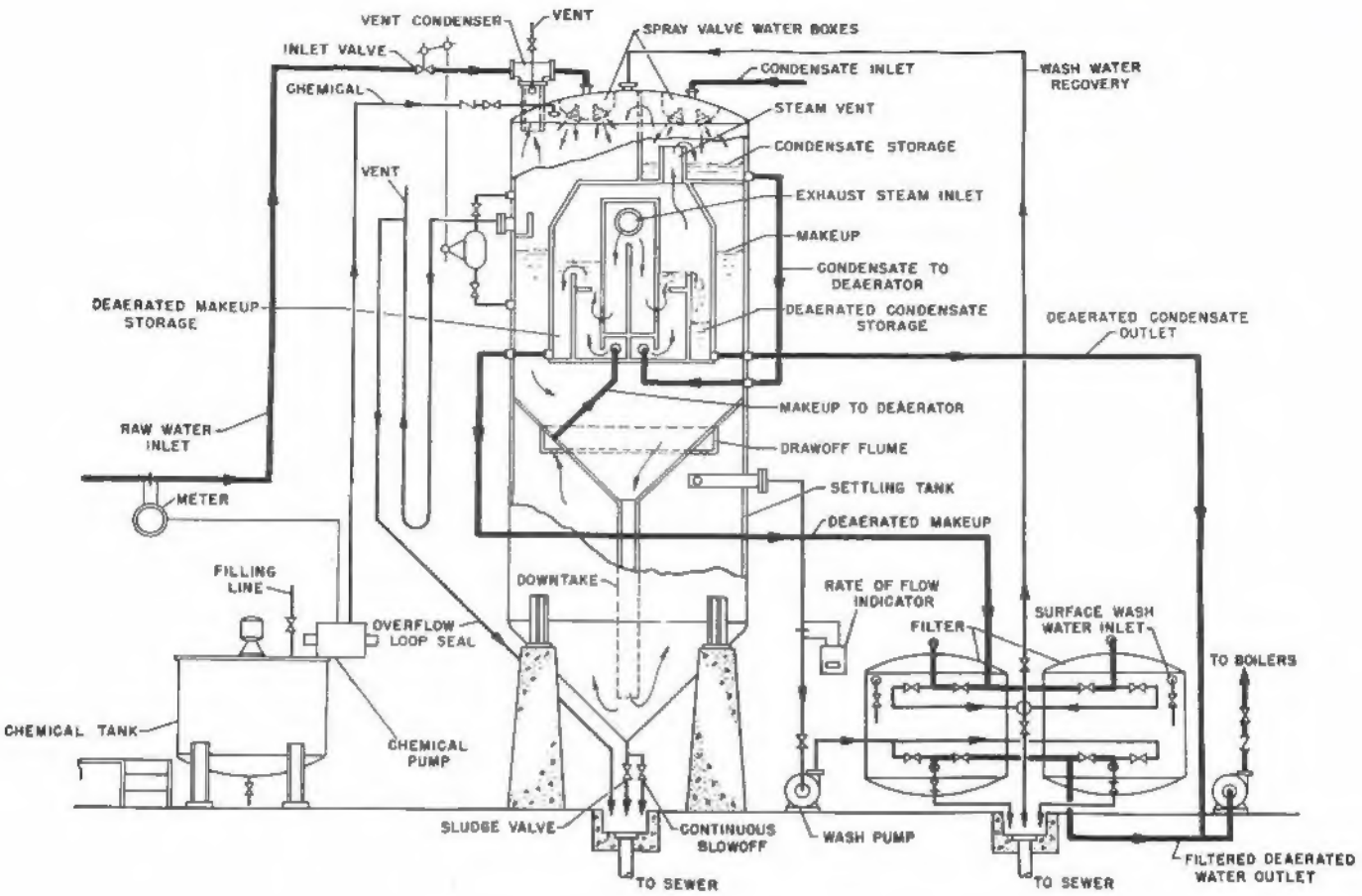


Fig. 5 Type BCD Permutit Hot Lime Soda Water Softener

TYPE BCD HOT PROCESS SOFTENER

A Combination Softener and Deaerator For Both Make-Up and Condensate

If condensate is to be collected in the Hot Process Softener, and both the condensate and treated make-up are to be deaerated, the Type BCD Hot Process Softener is recommended. This unit has separate heating and deaerating compartments for both condensate and make-up. Steam for deaerating the condensate and the make-up water enters through a single inlet connection into a steam chest which has a vertical partition separating the condensate and make-up at the lower part of the steam chest. From this common steam chest steam flows into the condensate scrubber and to the make-up scrubber. The deaerated condensate by-passes the settling tank reaction zone and the filters, going directly to the boiler feed pump suction. Deaerated softened make-up supplies the boiler feed only after all available condensate is used. The steam from the deaerator continues through steam vents into the condensate and make-up spray compartments.

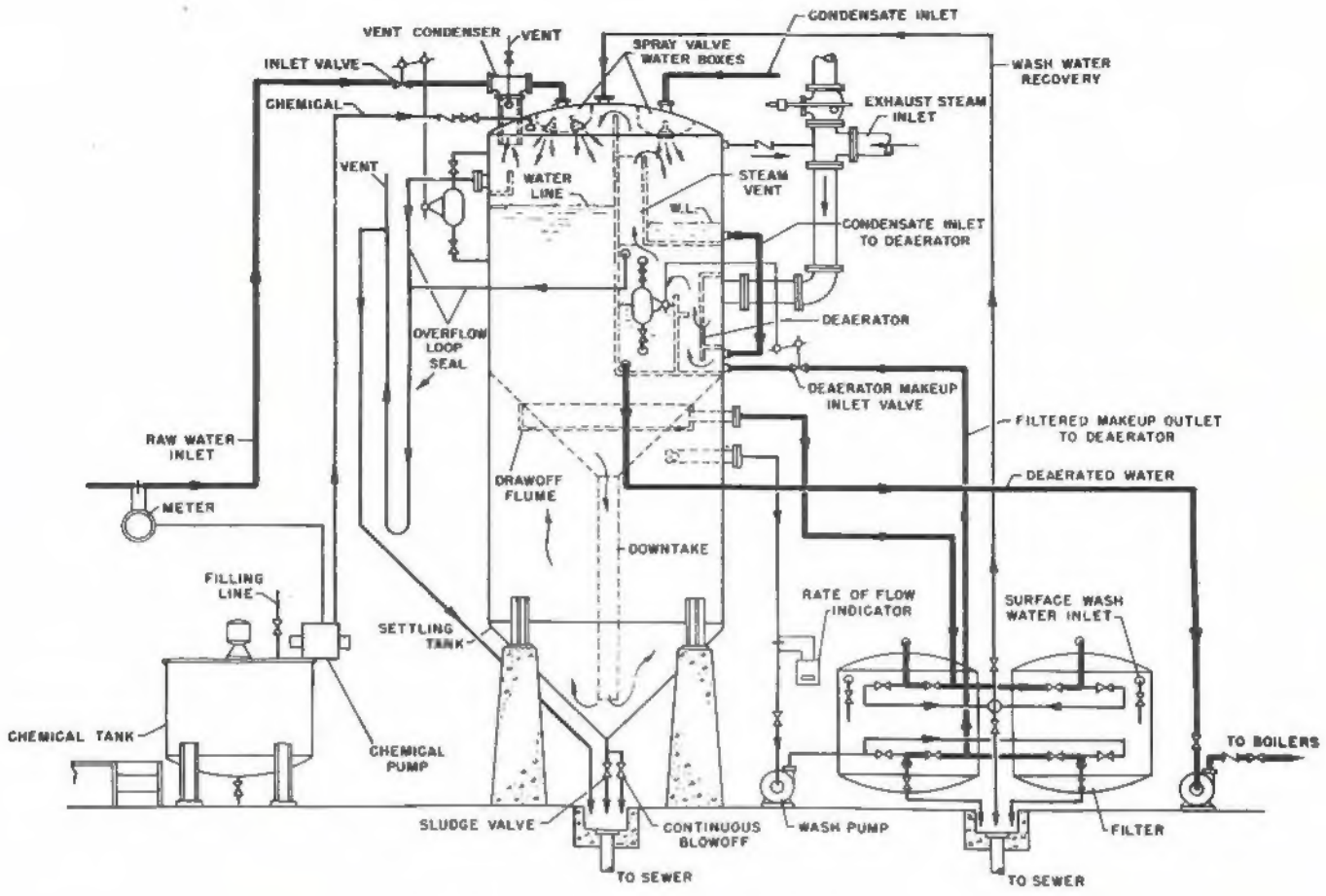


Fig. 6 Type BCDS Permutit Hot Lime Soda Water Softener

TYPE BCDS HOT PROCESS SOFTENER

A Combination System That Softens Make-Up and Deaerates a Mixture of Filtered Soft Water and Condensate

The Type BCDS Hot Process Softener is designed for plants having a large percentage of condensate for boiler feed, and is well suited when the condensate returns at intermittent rates. This type is generally recommended if the condensate exceeds 70% of the boiler feed.

Type BCDS differs from the Type BCD in that a single common deaerator compartment deaerates a mixture of preheated condensate and preheated, softened and filtered make-up.

Make-up water is heated, softened and filtered in the manner previously described. The filtered water then flows to the deaerator. Condensate is preheated then mixes with the filtered water at the deaerator inlet. A float-controlled regulating valve admits the filtered water, as required, to maintain a normal water level at about the central position of the deaerator storage compartment.

If more condensate returns than is required for the boiler feed, it is stored above the normal water level. If the boiler feed pump demands water much in excess of the rate of returning condensate, the storage of water below the normal water level supplies the boiler feed pump without placing excessive demands on the filter and settling tank. Storage of deaerated feed water between the filters and boiler feed pump tends to smooth out the peaks and valleys of make-up flow through softener and filters.

The elevated water level in the settling tank permits gravity flow through the filters and into the deaerator and storage compartment. This eliminates need for a pump.

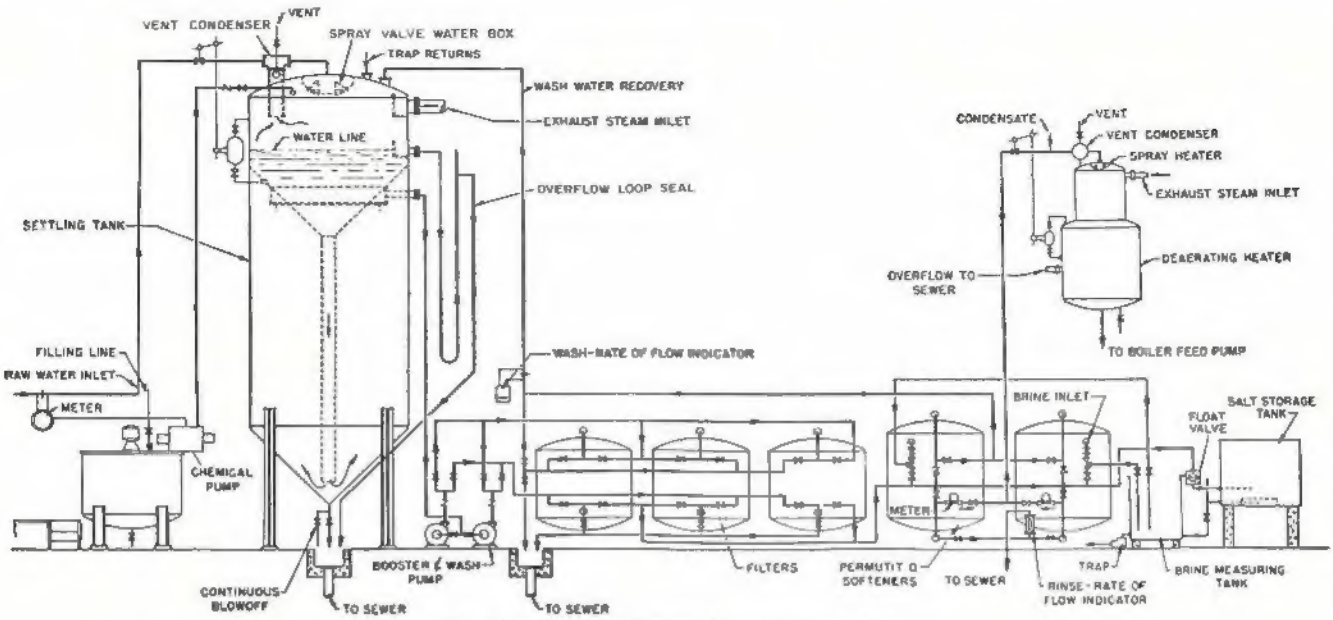


Fig. 8 Two-Stage Hot Process Lime and Zeolite Softeners

TWO-STAGE HOT PROCESS LIME and ION-EXCHANGE SOFTENER

Prior to 1950, the conventional arrangement for producing effluent close to zero hardness by the hot process system was to follow the hot lime-soda treatment with a second stage phosphate treatment. However, the introduction of styrene resins about 1950, provided an ion exchange material capable of withstanding high pH and temperatures up to 250°F. This made it possible to approach zero hardness in the second stage by the ion exchange process, which has proved more efficient and less expensive than secondary phosphate treatment.

This system combines the versatility of the hot process softener with the simplicity of the ion exchange softener to produce effluent that is low in alkalinity and silica and practically zero in hardness.

Earlier ion exchangers (zeolites) were not resistant to high temperature and high pH. Permutit Q, a sulfonated styrene resin, is able to withstand the high temperature and high pH and can therefore be used to soften hot lime-treated water.

The Permutit Hot Lime-Soda Softener, when used in combination with an ion exchange water softener, is known as a Two-Stage Hot Process Lime and Ion Exchange Softener. This first-stage is a conventional Hot Process Softener as previously described. The effluent from this unit is low in alkalinity and partially softened by the precipitation of calcium and magnesium from solution. It is also low in silica. Most of the precipitated solids are removed in the settling tank but the final trace of suspended matter is removed by passing the water through anthracite filters.

Final or second stage softening by cation exchange follows the filtration step in pressure-type ion exchange softeners. The final effluent of this system approaches zero hardness. The ion exchange unit is regenerated with salt in the usual manner. The unit is backwashed with hot treated filtered water which is usually returned to the filter inlet. Since the effluent from the hot process softener is comparatively low in hardness, the length of runs between regeneration are relatively long.

There are many outstanding advantages of the two-stage hot process lime and zeolite softener over the old two-stage hot lime-soda ash and secondary phosphate treatment.

A — Lower chemical cost — salt is cheaper than soda ash plus phosphate.

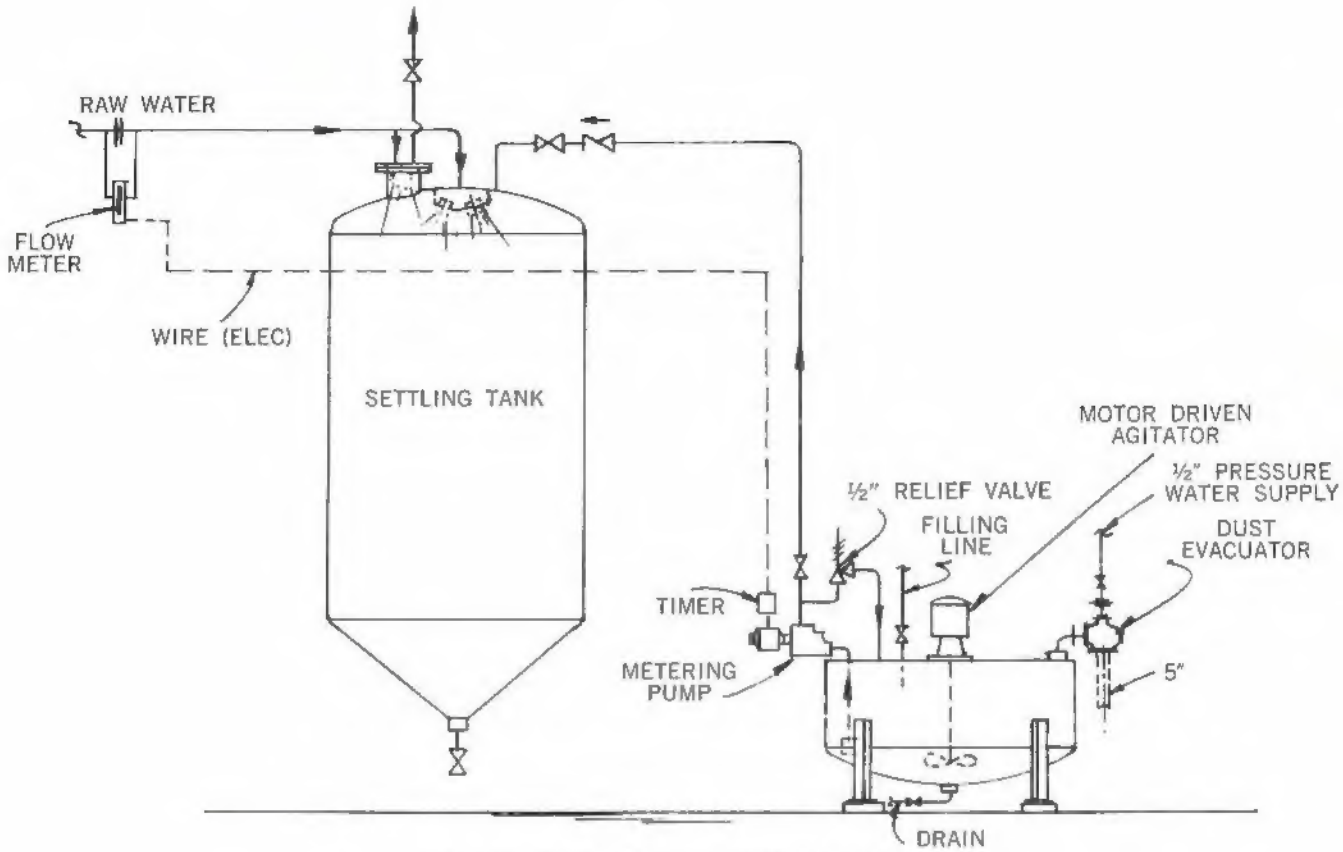
B — Lower alkalinity and lower total solids in the effluent.

C — No need for acid-feeding to prevent deposits in high stage heaters and economizers.

D — Easier to operate and the effluent is uniformly soft.

E — Conserves space — hot zeolite tanks more compact than second stage phosphate tank plus phosphate feeding equipment.

F — Simpler chemical control — only necessary to control lime to hot process tank rather than lime, soda ash, and phosphate.



CHEMICAL FEED ARRANGEMENT
HOT PROCESS SOFTENERS

CHEMICAL FEED SYSTEM

The Chemical Feed System is the heart of a Hot Lime Softening System. Essential requirements for a chemical feed system are:

1 — Accuracy of Control.
2 — Flexibility for easy variation of feeding rate.
3 — Durability and long life.
4 — Freedom from malfunction.

Permutit Chemical Feeders meet all of these requirements. Ruggedly constructed for dependable trouble-free operation, they are easy to adjust over a wide range of feeding rates. Design is simple and dependable. All parts are readily accessible for easy servicing.

Operation

A raw water meter with electrical contact initiates operation of the feeder which then measures and delivers the correct amount of chemicals for each unit volume of water entering the system.

Wet Feeders are recommended for capacities up to approximately 16,000 GPH.

Feeder includes:

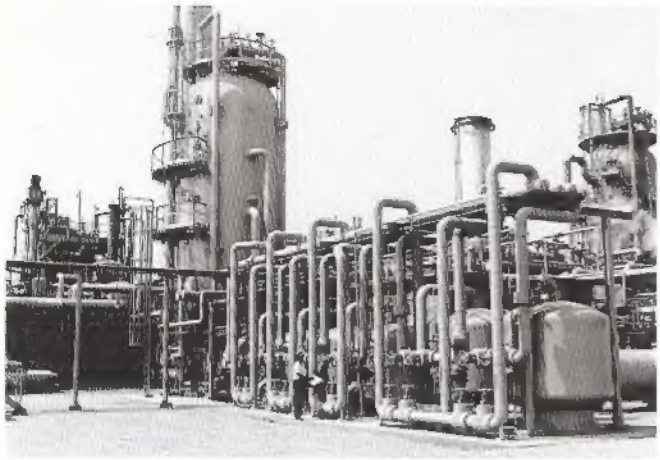
Slurry tank with agitator
Diaphragm pump and motor
Time switch to control duration of pump operation per meter contact
Interconnections.

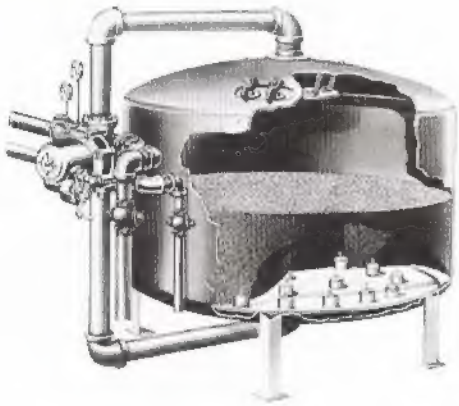
Dry Feeders are recommended for capacities above 16,000 GPH.

Type — Volumetric — Screw feed.

Feeder includes:

Storage hopper with agitator
Solution chamber with agitator
Control timer
Chemical pump — centrifugal
Heat exchanger to cool dilution water





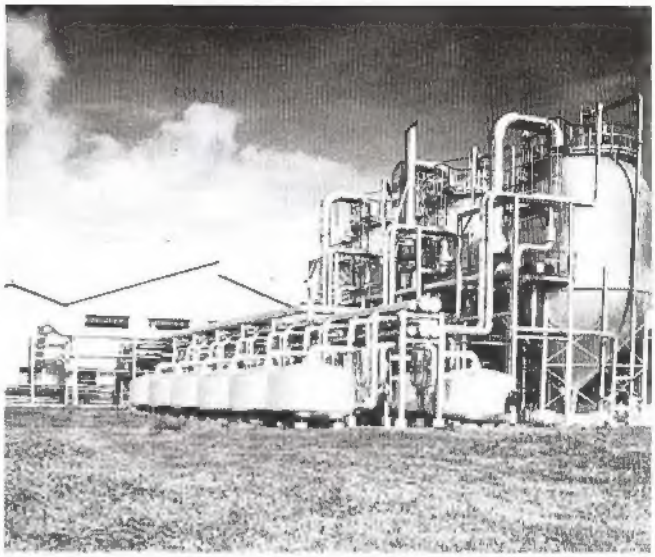
FILTRATION

To remove any remaining traces of suspended matter the treated water from the Hot Process Sedimentation Tank is passed through Pressure Filters containing anthracite filter media before it goes to the zeolite softeners and/or boiler feed pumps.

The Type "G", Permutit Pressure Filter is one of the most advanced filter designs yet developed. Most outstanding characteristic is its use of a single grade filter media. This is made possible by the patented double-dish underdrain which is the heart of the Type "G" design.

Here are just a few of its advantages: Needs no subfill. Reduces headroom requirement. Needs only one grade of filter media. Provides for uniform collection and distribution of water during filtering, backwashing and rinsing.

Other features of the Type "G" Filter, which are typical of all Permutit Pressure Filters, include heavy-gauge steel tank construction, and manual or automatic Multiport Valve control as well as conventional gate valves. Bulletin 2225F describes Permutit Pressure Filters in detail.



ION-EXCHANGE SOFTENING

When "zero soft" water is a requirement as compared to the usual 15 ppm to 25 ppm generally obtained by lime-soda treatment, ion exchange softeners are incorporated in the system following the pressure filters. High capacity Permutit "Q" resin, capable of withstanding temperatures up to 250°F, is used as the ion exchange material. Permutit offers a variety of sizes for manual or automatic operation to meet every requirement.

Construction Features include softener tank of heavy grade steel plate. Exclusive double-dish underdrain system which provides most efficient distribution and collection, avoids upset gravel beds by eliminating need for gravel, reduces rinse water requirements. Of equal importance is the upper distributor and lower collector system which utilizes stainless steel distributors and strainers. It is highly efficient and cuts maintenance costs.

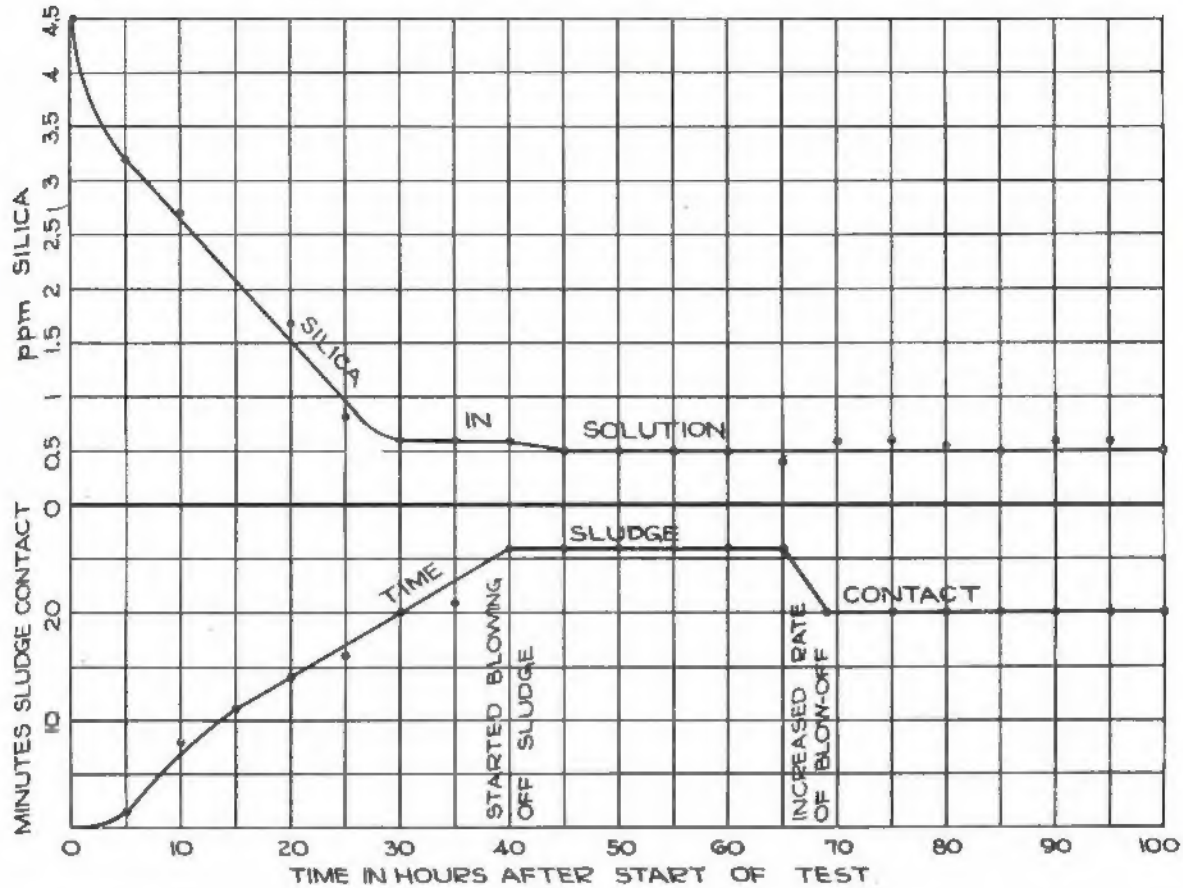
Single Valve is standard Permutit Multiport, either manual or automatic type.

Operation:

When the exchanger has exhausted its capacity to remove hardness, the unit must be regenerated. This is done by passing a brine solution through the bed of ion exchange resin. The concentrated brine solution reverses the ion exchange reaction and restores the exchanger's capacity to remove hardness. A single Permutit Multiport control valve performs all of the steps (service, backwash, regeneration, rinse, return to service) necessary for complete operation. Frequency of regeneration depends on the volume of water used and its hardness.

SPECIAL APPLICATIONS

Fig. 15 Removal of Silica by Magnesium Hydroxide with a Hot Process Sludge Blanket Softener



SILICA REMOVAL

Silica is removed by absorption or reaction with magnesium precipitated from the raw water. If there is insufficient magnesium in the raw water, additional magnesium oxide is fed. The most economical magnesium oxide is obtained from hydrated dolomitic lime, $Ca(OH)_2MgO$. If the dolomitic lime required for precipitation of the carbonates of calcium and magnesium does not give enough magnesium for silica removal, additional magnesium oxide must be added.

The dolomitic lime and additional magnesium oxide are fed from the standard lime and soda ash wet chemical feeders. If dry chemical feeders are used, a separate feeder will be required for each chemical.

REMOVAL OF SODIUM BICARBONATE ALKALINITY WITH SULFURIC ACID

Some waters contain more carbonate alkalinity than hardness. Such waters are said to have excess sodium bicarbonate. This sodium bircarbonate concentrates in the boilers to give excessively high caustic alkalinity and so much CO_2 with the steam as to cause serious corrosion of condensate-return piping. An economical method for removing the sodium bicarbonate alkalinity is to acid treat the raw water ahead of a hot process softener. If the excess alkalinity is very high, the acid treated water should be passed over a degasifier to remove most of the CO_2 before delivering the water to the softener. Treating the raw water with sulfuric acid changes the sodium bicarbonate to sodium sulfate and free CO_2.

REMOVAL OF SODIUM BICARBONATE ALKALINITY WITH CALCIUM SULFATE

For small plants where the cost of chemicals is not of great importance, the excess sodium carbonate can be removed by feeding gypsum with the lime into the hot process softener. This avoids the need for a sulfuric acid feeder and degasifier. The final results in the effluent are the same in either event. The cost of the gypsum and additional lime is substantially higher than the cost of sulfuric acid for the work accomplished.

PERMUTIT®

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